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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/838,513	04/20/2001	Shaoyin Chen	CS00-122	9429

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EXAMINER

MALDONADO, JULIO J

ART UNIT	PAPER NUMBER
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2823

DATE MAILED: 11/19/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

23

Office Action Summary	Application No. 09/838,513	Applicant(s) CHEN ET AL.	
	Examiner Julio J. Maldonado	Art Unit 2823	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 22 August 2003.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-21 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-21 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. §§ 119 and 120

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
* See the attached detailed Office action for a list of the certified copies not received.
- 13) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application) since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.
a) ☐ The translation of the foreign language provisional application has been received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121 since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) Paper No(s). _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

2. Claims 1-21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Mouroux (The reactive formation of TiSi_2 in the presence of refractory metals) in view of Erhardt et al. (U.S. 6,514,859 B1) and Ishida (U.S. 5,937,325).

In reference to claims 1, 8 and 15, Mouroux (Figs. 2, 9, 12-14 and 17) in a related art to the formation of titanium disilicide layers teaches providing a semiconductor substrate having silicon regions to be silicided; depositing a titanium layer directly overlying said silicon regions to be silicided; subjecting said substrate to a first annealing at a temperature less than 700°C , whereby said titanium is transformed to phase C40 titanium disilicide where it overlies said silicon regions and where said titanium not overlying said silicon regions is unreacted; subjecting said substrate to a second annealing whereby phase C54 titanium disilicide is grown overlying said phase C40 titanium disilicide and whereby said phase C40 titanium disilicide is transformed to phase C54 titanium disilicide; and removing said unreacted titanium layer to complete formation of said integrated circuit (page 6-14, 17, 24-28, 30, 37 and 38).

The teachings of Mouroux fail to teach the first annealing is laser annealing. However, Ishida (Figs.2-4) in a related method to form low resistivity titanium silicide

layers teaches performing a first annealing, where said annealing is a laser annealing (column 4, lines 5-22). Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to use a laser anneal as taught by Ishida in the in the first annealing step of Mouroux, since this would allow the selective formation of titanium disilicide in some regions while leaving others unreacted (column 4, lines 5-22). Also, it would have been obvious to combine the teachings of Mouroux and Ishida to enable the silicide formation step of Mouroux to be performed and furthermore because Erhardt et al. indicate the steps to be interchanged (Erhardt et al., column 2, lines 37 – 65).

In reference to claims 2, 9 and 16, Mouroux teaches said silicon regions to be silicided comprising gate electrodes and associated source and gate regions (Figure 2).

In reference to claims 3, 10 and 17, Mouroux teaches sputter depositing a titanium layer at a thickness rate of 0.5 nm/s (page 15). However, Mouroux fails to teach having a thickness between about 100 and 500 angstroms. Notwithstanding, it would have been an obvious matter of design choice bounded by well known manufacturing constraints and ascertainable by routine experimentation and optimization to choose these particular dimensions because applicant has not disclosed that the dimensions are for a particular unobvious purpose, produce an unexpected result, or are otherwise critical, and it appears prima facie that the process would possess utility using another dimension. Indeed, it has been held that mere dimensional limitations are prima facie obvious absent a disclosure that the limitations are for a particular unobvious purpose, produce an unexpected result, or are otherwise critical. See, for example, *In re Rose*,

220 F.2d 459, 105 USPQ 237 (CCPA 1955); In re Rinehart, 531 F.2d 1048, 189 USPQ 143 (CCPA 1976); Gardner v. TEC Systems, Inc., 725 F.2d 1338, 220 USPQ 777 (Fed. Cir. 1984), cert. denied, 469 U.S. 830, 225 USPQ 232 (1984); In re Dailey, 357 F.2d 669, 149 USPQ 47 (CCPA 1966).

In reference to claims 4, 5, 11, 12, 18 and 19, the combined teachings of Mouroux, Erhardt et al. and Ishida teach performing a first annealing, where said annealing is a laser annealing using an Excimer laser having a wavelength of 308 nm and an energy between about 0.3 and 1.0 joules/cm² (column 4, lines 5-22). Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to use a laser anneal as taught by Ishida to arrive at the claimed invention, since this would allow the selective formation of titanium disilicide in some regions while leaving others unreacted (Ishida, Figs.2-4 and column 4, lines 5-22).

The combined teachings of Mouroux, Erhardt et al. and Ishida fail to teach laser annealing having a wavelength of 1.06 nm and using an Excimer laser having a wavelength of 248 nm. However, the selection of the claimed ranges are obvious because it is a matter of determining optimum process condition by routine experimentation with a limited number of species. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use the above-mentioned specifications to arrive at the claimed invention.

In reference to claims 6, 7, 13, 14, 20 and 21, Mouroux teaches said second annealing is a rapid thermal annealing performed at a temperature between about 550

and 860°C for 0.5 to 2 minutes, or by furnace annealing at a temperature of between about 500 and 750°C for 5 to 60 minutes (pages 19, 27 and 28).

Response to Arguments

3. Applicant's arguments filed 08/22/2003 have been fully considered but they are not persuasive.

Applicants argue, "... It is agreed that Mouroux teaches a method of forming C4O and then titanium silicide... However, Mouroux requires presence refractory metal such as Mo to form C4O phase. This can be in the form of a refractory metal layer underlying the titanium, refractory metal implanted into the silicon regions, or an alloy of a refractory metal with the titanium... Mouroux... states that a refractory metal layer is 'introduced as a thin interposed layer... between the Si and the substrate and the Ti films'. Thus, the titanium layer is not deposited 'directly overlying said silicon regions to be silicidized'...". In response to this argument, Mouroux teaches that one way to form C54 TiSi_2 is by depositing an interposed layer between the titanium and the substrate. However, Mouroux also teach performing a refractory metal implantation (see Fig.9(b)) prior to form the titanium layer. Therefore, the condition of "depositing a titanium layer directly overlying said silicon regions to be silicidized" as claimed is met in Mouroux.

Applicants also argue, "... laser annealing is not taught or suggested by Mouroux since Mouroux requires the presence of a refractory metal to form the C40 phase TiSi_2 . Ishida teaches laser annealing to form C49 phase TiSi_2 ... Mouroux teaches forming C54 TiSi_2 by first forming a C40 phase silicide layer incorporating a refractory metal... It is agreed that Erhardt et al. teach laser annealing as an alternative to RTA or furnace

annealing. However, Erhardt et al. does not disclose a second annealing to change the phase of the silicide formed in the first annealing. Erhardt et al. does not recognize the necessity of formed a C54 phase titanium disilicide. There would be no motivation to combine the laser annealing of Ishida which forms phase C49 titanium silicide with Mouroux which forms phase C40 silicide...". In response to this argument, Mouroux teaches performing a first thermal process to form a C40 titanium silicide. Mouroux also teaches performing a second thermal process to form a C54 titanium silicide, wherein the thermal processes comprises annealing (Mouroux, Fig.2). By combining the teachings of Mouroux (page 6-14, 17, 24-28, 30, 37 and 38) with Ishida Erhardt et al., it would have been obvious to one of ordinary skill in the art at the time the invention was made to use laser annealing to cause a phase change in a titanium silicide layer as taught by Ishida instead of the RTA process as taught in the C54 TiSi_2 process of Mouroux, since these processes can be interchangeable as taught by Erhardt.

Conclusion

4. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).


A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of


the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

5. Papers related to this application may be submitted directly to Art Unit 2823 by facsimile transmission. Papers should be faxed to Art Unit 2823 via the Art Unit 2823 Fax Center located in Crystal Plaza 4, room 3C23. The faxing of such papers must conform to the notice published in the Official Gazette, 1096 OG 30 (15 November 1989). The Art Unit 2823 Fax Center number is **(703) 305-3432**. The Art Unit 2823 Fax Center is to be used only for papers related to Art Unit 2823 applications.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to **Julio J. Maldonado** at **(703) 306-0098** and between the hours of 8:00 AM to 4:00 PM (Eastern Standard Time) Monday through Friday or by e-mail via julio.maldonado@uspto.gov. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri, can be reached on (703) 306-2794.

Any inquiry of a general nature or relating to the status of this application should be directed to the **Group 2800 Receptionist** at **(703) 308-0956**.


JMR
11/8/03


George Fourson
Primary Examiner